

LA-UR-19-22648

Approved for public release; distribution is unlimited.

Title: Design of Experiment To Test Fast Electronics For Neutron Noise Measurements. (IER 453)

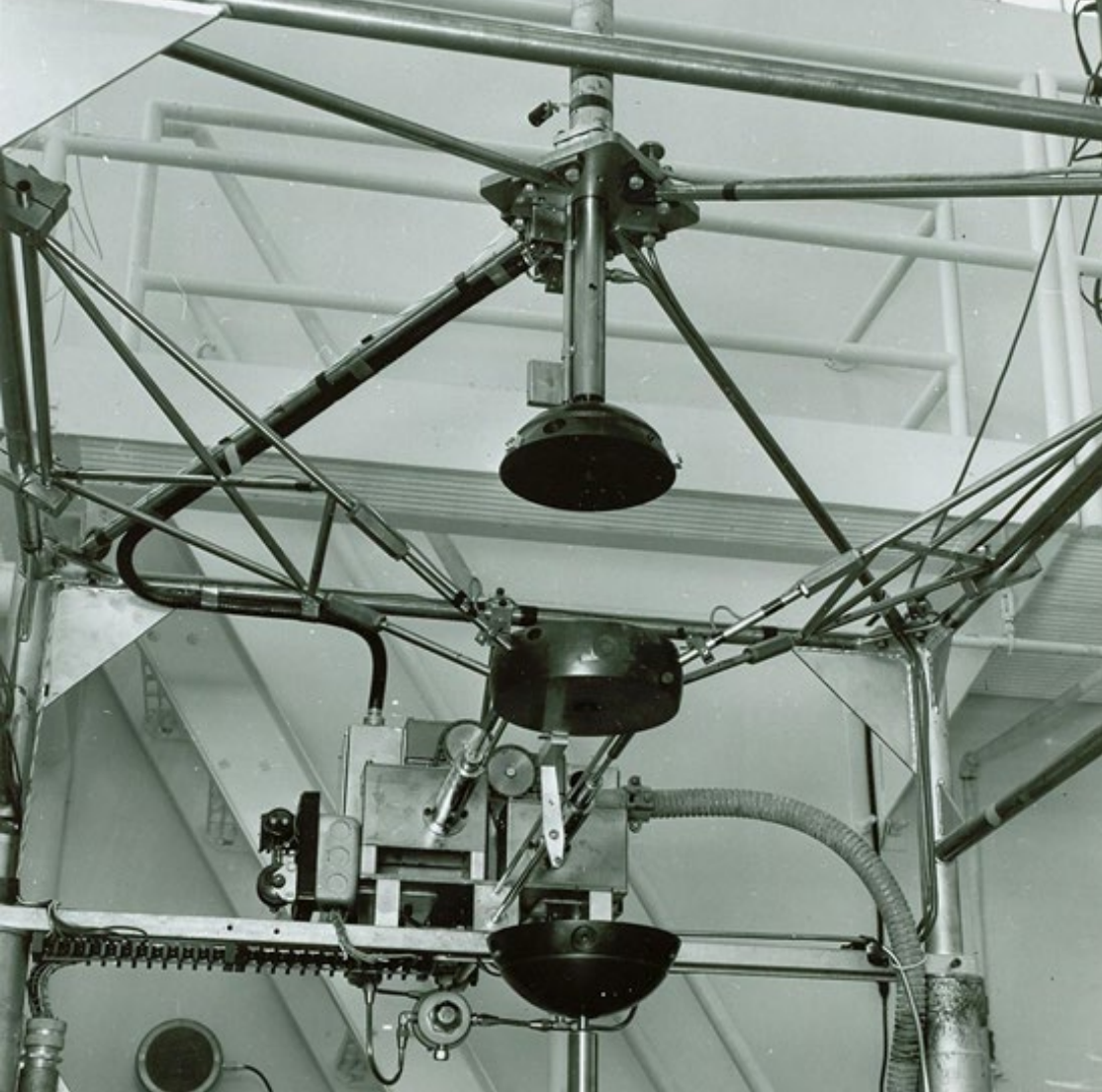
Author(s): McKenzie, George Espy IV
Grove, Travis Justin

Intended for: NCSP Technical Program Review

Issued: 2019-03-25

Disclaimer:

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by Triad National Security, LLC for the National Nuclear Security Administration of U.S. Department of Energy under contract 89233218CNA000001. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.



• **Los Alamos**
NATIONAL LABORATORY
— EST. 1943 —

Delivering science and technology
to protect our nation
and promote world stability

Design of Experiment To Test Fast Electronics For Neutron Noise Measurements. (IER 453)



George McKenzie and Travis Grove

March 27, 2019

Overview

- **Why is a “fast” neutron measurement system a necessary upgrade to NCERC?**
 - Previous experiments performed
 - Capabilities previously at LACEF
- **Chosen system components**
- **Planned testing and measurements**
 - Godiva IV (known test)
 - Other fast systems (unknown tests)
- **Execution timeline**

Previously Performed Experiments

- **Current neutron noise measurement capabilities at NCERC all consist of He-3 detection systems.**
- **He-3 tubes have dead-times on the order of μs .**
- **Fast/bare systems like Godiva IV are impossible to measure as the prompt decay signature happens within the tube dead-time.**
- **Attempted to measure decay signature on Godiva with N-generator**

Previous Neutron Noise Capabilities at LACEF

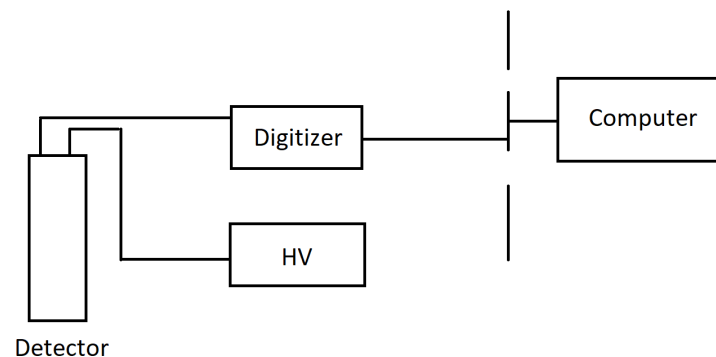
- **At LACEF, neutron noise measurements were performed as early as the 1940s.**
- **The systems implemented there were capable of measuring the prompt decay on bare systems such as Lady Godiva.**
- **These systems implemented He-3 detectors, proton recoil detectors, stilbene detectors, and fission chambers.**

Fast Neutron Noise Measurement System

- **IER 453 proposed implementation of a new scintillation detector system to be used in neutron noise measurements on fast systems.**
- **Scintillators were chosen because of their speed.**
- **New electronics system is capable of being used with a wide variety of detection systems.**

New Fast Electronics System

- **Consists of liquid and plastic scintillators**
 - EJ-309 (liquid)
 - EJ-276 (plastic)
- **Fast timing digitizer (500 MS/s)**
- **High Voltage Supply**
- **Computer**
- **Software for n/γ discrimination and neutron timing**
 - Simple system creates less complication in setup and execution.



Equipment



Equipment



BeRP Ball Reflected by Be

- **Request to design experiment with Be reflector**
- **Experimental Goals:**
 - Experiment has high sensitivity to Be (scattering) cross sections
 - Ability to measure configurations at subcritical, critical, and supercritical
 - Ability to change reactivity/ k -effective by small amounts
 - Ability to construct numerous subcritical configurations

BeRP Ball Reflected by Be

- **Design Constraints:**

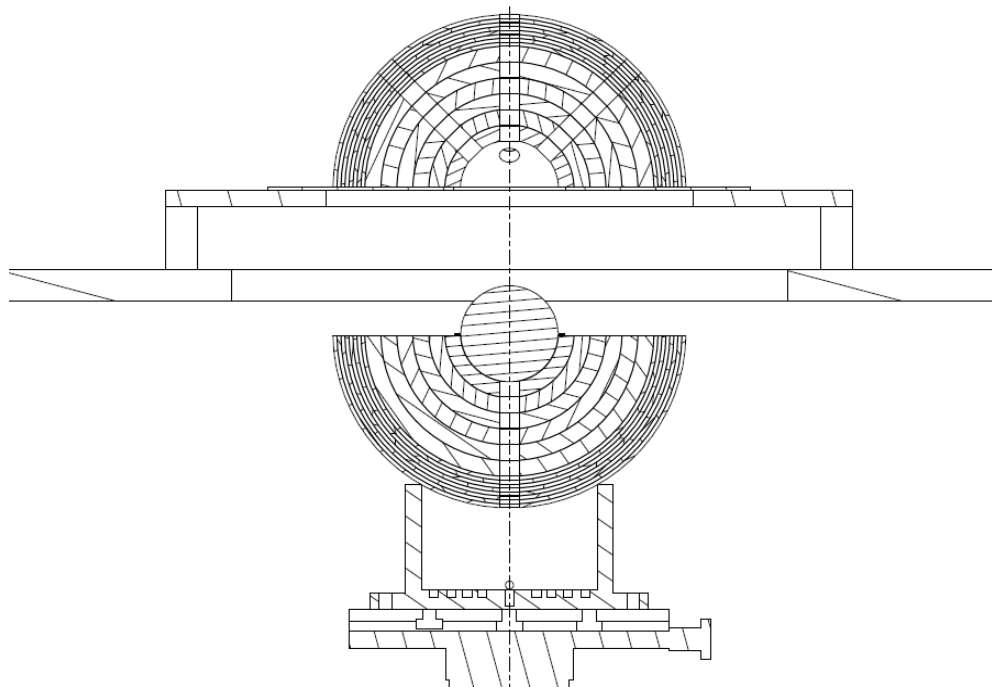
- The ability for the configuration to be built using a hand-stack approach – i.e., the ability to slowly approach the critical configuration.
- The ability for the configuration to also support construction of numerous high-multiplication subcritical configurations.
- The ability for the configuration to allow for experimental access – ie, the ability to add to the experiment such items as RTDs to measure temperature, small neutron detectors, fission chambers, etc.
- The ability for the configuration to precisely determine the alignment, to assist in benchmarking of critical and subcritical configurations.
- The ability for the configuration to add or remove reactivity in large amounts (i.e., coarse control of reactivity).
- The ability for the configuration to add or remove reactivity in small amounts (i.e., fine control of reactivity).
- A high cross section sensitivity to Be.

BeRP Ball Reflected by Be

- Previous calculated critical thickness (theoretical density, no impurities, no gaps): 2.5"-3.2" Be reflector
- PMF-038: 3.349" Be reflector
- Design calculations: 3.375"

BeRP Ball Reflected by Be

- **Be hemishells surrounding BeRP ball**
- **Critical Assembly Machine: Planet or Comet**
 - Half the hemishells sit on moveable platen (along with BeRP ball)
 - Half the hemishells sit on Be membrane
- **Critical configuration achieved by moving platen up to membrane**
- **Polar holes: Experimental access, alignment, reactivity adjustment**

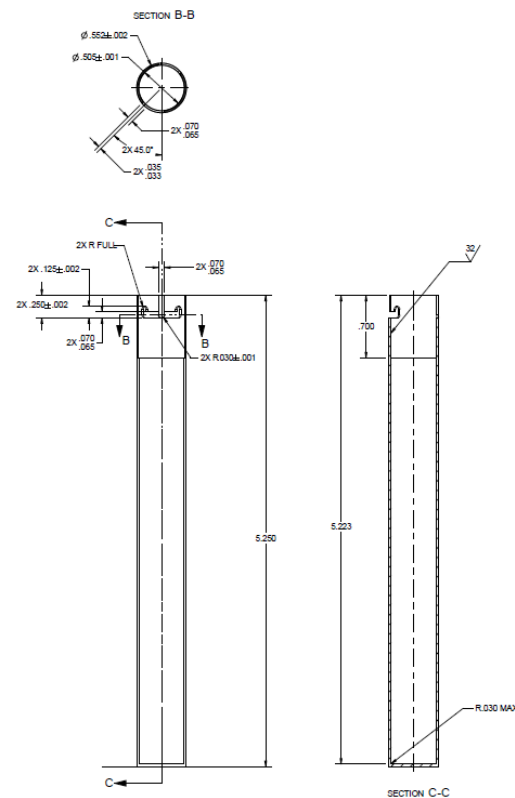


BeRP Ball Reflected by Be

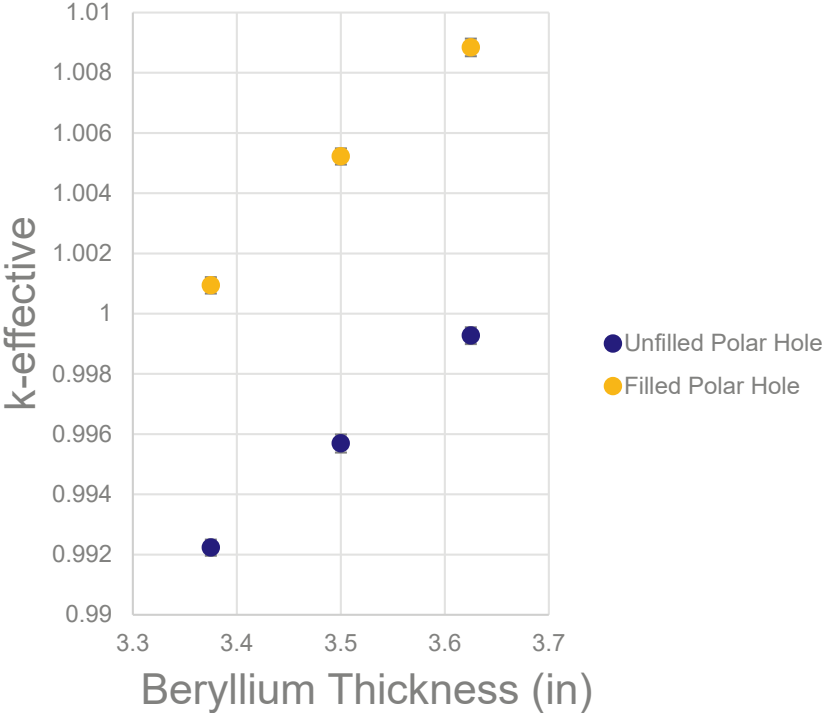
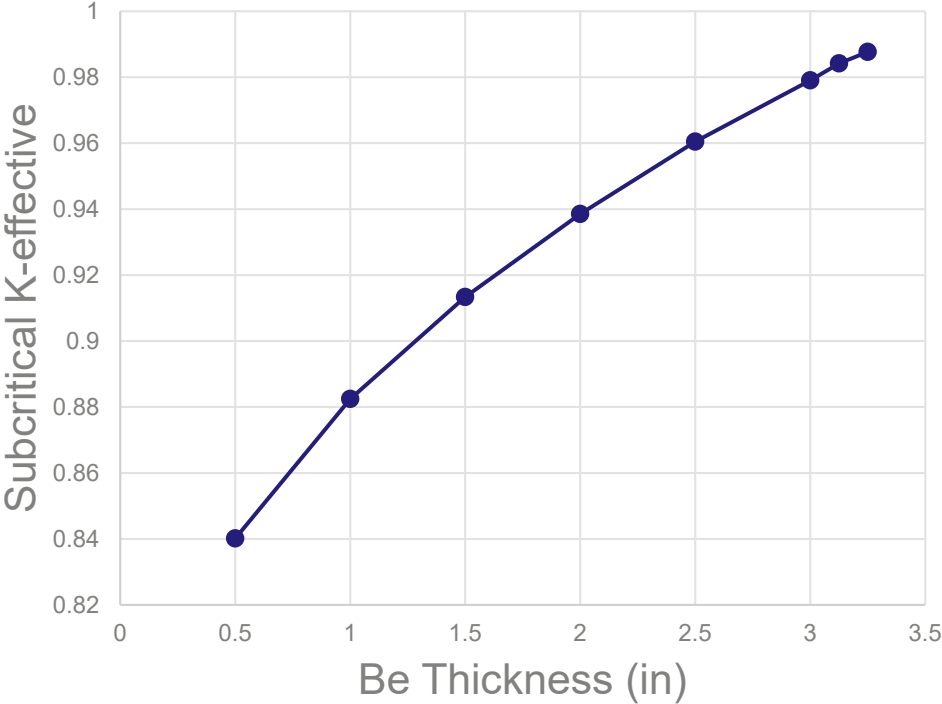
- **Hemishells: Allow for coarse reactivity addition as well as a hand stack approach**
 - High multiplication subcritical configurations
 - Future experiments could interleave other materials
 - Hemishells made male/female for alignment on membrane
 - Hemishell Thickness: 1/8" to 1/2"
 - Alternate membrane designed for subcritical measurements/handstacks not on critical assembly machine

BeRP Ball Reflected by Be

- **Six polar holes (five upper, one lower):**
 - Experimental access (RTDs, detectors, fission chambers, irradiation samples, etc)
 - Fine reactivity control
 - Experimental alignment
 - Polar hole dimensions based upon existing sample sizes (Godiva, Flat-Top)
 - Thin Al sheath lining



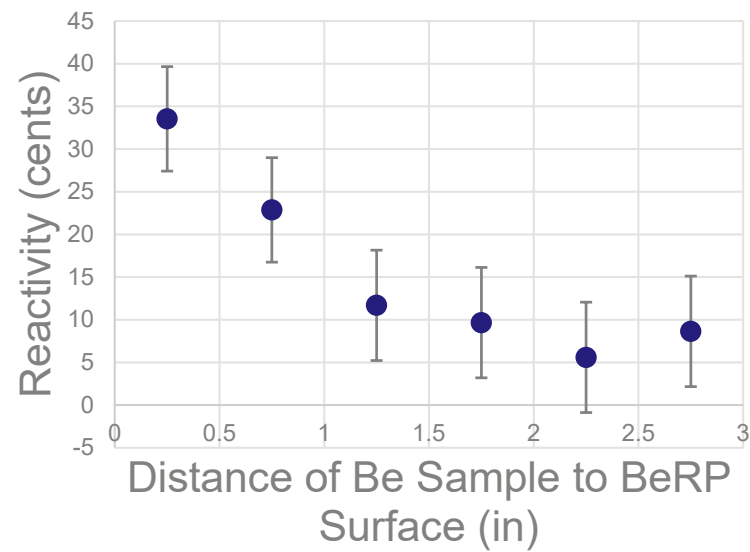
BeRP Ball Reflected by Be



BeRP Ball Reflected by Be

Isotope	(n,2n)	Fission	Elastic	Total
Be-9	2.38E-02	N/A	2.67E-01	2.88E-01
Pu-239	2.64E-04*	6.77E-01	2.58E-02	7.02E-01
Pu-240	6.96E-05*	2.64E-02	5.73E-04*	2.59E-02

* Indicates large relative uncertainties in the calculations



BeRP Ball Reflected by Be

- **Final design is being iterated upon**
- **Working with interested parties to determine if design meets goals and needs**

Timeline for IER 453

- **Components have been ordered.**
- **Currently in discussions about the design of stands to secure detection system.**
- **Expect testing and set-up at LANL in Q3.**
- **Ship to NCERC.**
- **Measurements on Godiva IV expected end of Q3.**
- **Plan for unknown testing in FY20.**

This work was supported by the DOE Nuclear Criticality Safety Program, funded and managed by the National Nuclear Security Administration for the Department of Energy.
